Chemical Microscopy Studies of Photoresist Polymers

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Decreasing line dimensions in photoresist materials for patterning of electronic, display, and data storage device components demands better characterization techniques for assessing rates of photo-acid diffusion and roughness of nanoscale line features. We have developed an apertureless near-field optical scanning microscope (ANSOM) (Fig. 1) for the characterization of the line dimensions and diffusion characteristics of photoresist chemistry at nanometer resolution. Preliminary results demonstrate <20 nm spatial resolution on gold nanoparticles and work is in progress to adapt this to photoresist studies, where line dimensions of 60 nm will be a standard in the industry before long. Also, we have carried out, in collaboration with Sunney Xie's group at Harvard, a vibration-specific CARS (coherent Anti-Stokes Raman Scattering) imaging study of interferometrically patterned PTBOCST [poly(t-butyloxycarbonyloxystyrene)] photoresist polymer samples (Fig. 2). The result of the CARS imaging study shows the potential for relatively rapid, real-time, *in-situ* monitoring of photoresist chemistry, which will help to optimize the photoresist development process.

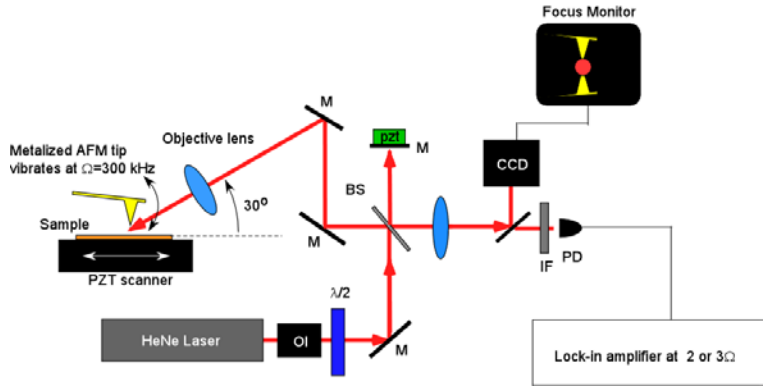

Fig. 1: Schematic diagram of Apertureless-NSOM apparatus

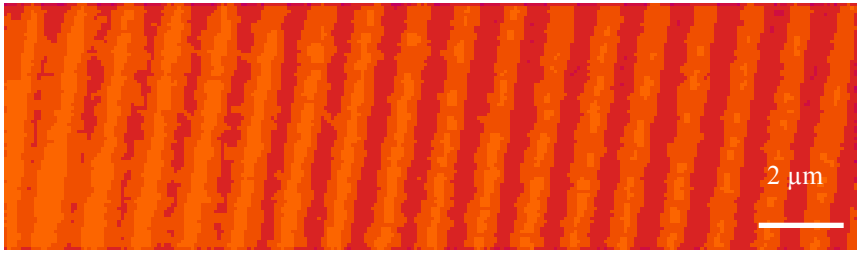

Fig. 2: CARS image of interferometrically patterned PTBOCST [poly(t-butyloxycarbonyloxystyrene)] obtained by probing the carbonyl stretching vibration of the tert-butoxyl carbonyl group of PTBOCST. The experimental images demonstrate high spatial resolution (≈ 270 nm) with vibration-specific contrast.

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Education:

One graduate student (Laurie McDonough, one postdoc (Zee Hwan Kim, and one visiting student from Germany (Sandra Boerner) worked on this project. This work fostered an exchange interaction with the laboratory of Wolfgang Schade at the Technical University of Clausthal, Germany. In addition, a collaboration between IBM scientists resulted in visits of IBM staff to Berkeley and our group to IBM.

Outreach:

Underrepresented students participating in the Berkeley Edge Program visited the laboratory, and two summer interns (high school and college) working at the Advanced Light Source also participated in the Leone group.